09/701184
528 Rec'd PCT/PTO 27 NOV 2000

2/PRTS

a

~~Description~~

INS A8>

Method and circuit arrangement for restoring a binary signal

INS A3>

The invention relates to a method and a circuit arrangement for restoring a binary signal, which can be transmitted via an optical transmission link, from a distorted binary signal, the optical transmission link exhibiting a distortion time.

INS A4> Repeaters in optical data transmission systems usually receive binary signals with a time distortion due to attenuations within the transmission link. This means that the distorted binary signals are either over- or underdriven due to signal changes and the Low or High pulses are either elongated or shortened. These disturbances must be rectified by the repeater before it forwards the binary signal to another repeater or receiver.

The binary signal can be regenerated from a disturbed binary signal by, e.g. a starting edge of the disturbed binary signal triggering a sampling circuit which in each case samples the level of the binary signal at the midpoint of the bit. For this purpose, however, it is necessary that the sampling circuit accurately knows the clock rate of the binary signal as a result of which the latter must be provided with an elaborate Baud rate detection circuit or with a Baud rate adjustment switch. In addition, the sampling of the binary signal at the midpoint of the bit increases the signal transit times in extensive optical waveguide systems, especially in the case of binary signals with low Baud rates.

Ins A5>

a

The present invention is based on the object of a simplifying method of the type mentioned initially. In addition, a circuit arrangement for carrying out the method ~~must be~~ is specified.

INS B1

The object is achieved by the following method steps with regard to the method:

- determining time intervals which in each case comprise at least twice the distortion time, the clock rate of the binary signal comprising an integral multiple of one time interval,
- detecting level changes of the distorted binary signal in the time intervals,
- determining level holding times of the distorted binary signal which in each case indicate how long a level remains unchanged within a time interval,
- restoring the binary signal in the time intervals
  - by transferring the detected level in the time intervals in which no level changes have taken place in the distorted binary signal, and
  - by transferring the detected level in the time intervals in which level changes have taken place, only when the respective level holding times reach a predeterminable value.

The object with regard to the circuit arrangement is achieved by the measures specified in the characterizing clause of claim 4.

INS B2

It is advantageous that, in order to restore the binary signal, its Baud rate does not need to be known exactly to the receiving subscriber of an optical data transmission system. It is only necessary to set in the subscriber time intervals which, in each case, ~~comprise~~ include at least twice the

a
a

distortion time. This distortion time can be found in technical data sheets of optical waveguide transmission links. Furthermore, the clock rate of the binary signal must be set as an integral multiple of one time interval, as a result of which the level of the disturbed binary signal does not change at an integral multiple of a time interval and thus within a time interval in the case of a time distortion (shortening or elongation of the Low or High level). This "time segment", i.e. the level holding time within a time interval which indicates how long the level remains unchanged within a time interval, is weighted in such a manner that the level which is valid before or after the level change is set for restoring the binary signal in this time interval. In this arrangement, it is provided to transfer the level detected within this time interval only if the level holding time reaches a predeterminable value.

In a practical exemplary embodiment of the invention, the time intervals are fixed at in each case approx. 83.33 ns on the basis of the technical data of the components and the maximum permissible lengths of the optical waveguides. The clock rates of the binary signals to be transmitted via optical waveguides are an integral multiple of this time interval Baud rates of 12 MB, 3 MB, 1.5 MB and 500 KB are provided in the example. In the case where the data clock rate of the binary signal is transmitted at 500 KB, a signal data bit comprises 24 time intervals of in each case 83.33 ns in undisturbed operation.

In one embodiment of the invention, the type of distortion "elongated or shortened Low or High pulse", which can be determined in an identification mode of operation, is also taken into consideration for weighting the level holding times, for restoring the binary signal in the time intervals in which level changes took place. The type of distortion is characteristic of an optical waveguide transmission link and

usually does not change abruptly but remains virtually constant. The identification mode of operation is set before the transmission of user data and, in this mode of operation, test data are transmitted which are stored both in a transmitter and in a receiver. A comparison of the received test data with the test data stored in the receiver enables a conclusion to be drawn regarding the type of distortion.

In a further embodiment of the invention, after each level change, the subsequent time intervals Zi are synchronized which ensures that these time intervals remain constant during the period of restoration of the binary signal. INS A67 ~~INS A77~~

In the text which follows, the invention, its embodiments and advantages will be explained in greater detail with reference to the drawing~~s~~ in which an exemplary embodiment of the invention is illustrated and in which:

Figures 1 and 2 are ~~show~~ timing diagrams of a disturbed binary signal and of a regenerated binary signal. INS A87

In figure 1, element 1 designates a disturbed binary signal which is underdriven during the transmission via an optical transmission link provided with optical waveguides and has shortened High levels 2 and elongated Low levels 3. For the weighting and evaluation of the disturbed binary signal, time intervals Z1, Z2, ... Zn having in each case a length of 83.33 ns are specified which, in each case, include ~~comprise~~ at least twice the distortion time of the optical transmission link. In the present example, the time intervals Zi, i = 1, 2, ... n, are in each case subdivided into ten subintervals Ux, x = 1, 2, ... 10. This ~~which~~ means that one subinterval Ux includes ~~comprises~~ 10% of one time interval Zi. For the sake of simplicity, the clock rate of the binary signal corresponds to the length

of the time interval in the present example, which corresponds to a Baud rate of 12 MB.

In the text which follows, it is assumed that, in order to restore the binary signal, a detected level in the disturbed binary signal 1 in a time interval Zi is only transferred for this time interval if the level holding time exceeds 30% in this time interval.

In the present example, a 0 level P01 of the disturbed binary signal 1 is present in the entire time interval Z1. The level holding time Ph11 of 30% of the time interval Z1 is exceeded as a result of which this 0 level P01 for the time interval Z1 is transferred for restoring a binary signal 4. In the time interval Z2, a level change from a 0 level to a 1 level is detected, where a level holding time Ph21 of the 0 level comprises 30% of the time interval Z2 and a level holding time Ph22 of the 1 level comprises 70% of the time interval Z2. A 1 level P12 is therefore transferred for the entire time interval Z2. After a further level change of the disturbed binary signal 1 at the beginning of the time interval Z3 from a 1 level to a 0 level, this 0 level remains constant in time intervals Z3 ... Z7 and only changes again after a level holding time Ph81 which comprises 30% of the time interval Z8. A 0 level P03 ... P07 is therefore transferred for time intervals Z3 ... Z7 for restoring the binary signal 4, but a 1 level P18 is transferred for the entire time interval Z8. This 1 level is also retained for the remaining time intervals and the entire binary signal 4 is thus restored and the time distortions are eliminated.

In the text which follows, reference is made to figure 2 in which a disturbed binary signal 5 is shown which is overdriven during the transmission via an optical waveguide and exhibits elongated High levels 6 and shortened Low levels 7. The parts which

are identical in the figures are provided with the same reference symbols.

In the text which follows, it is assumed again that, in order to restore a binary signal 8, a detected level in the disturbed binary signal 5 in a time interval Zi is only transferred for this time interval if the level holding time exceeds 30% of the time interval. In the present case, this means that, in the entire time interval Z1, the binary signal 8 to be restored is provided with a 0 level P01 since the disturbed binary signal 5 exhibits a 0 level for 70% of the time interval Z1. In accordance with the manner described, a 1 level P11 is transferred in time interval Z2, a 0 level P02 ... P07 is transferred in time intervals Z3 ... Z7 and a 1 level P18 ... P1n is transferred in time interval Z8 and the subsequent time intervals.

Ins A9>